Steam ESA 042-3_United Ethanol, Milton, WI
Public Report - Final

Company	United Ethanol	**ESA Dates**	March 5th to 7th
Plant	Milton, Wisconsin	**ESA Type**	Steam
Product	Ethanol & Co-products	**ESA Specialist**	Tom Tucker, P.E.

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:
On behalf of the Department of Energy, Tom Tucker of Kinergetics LLC conducted a steam system ESA at the United Ethanol facility in Milton, Wisconsin from March 5th to 7th, 2007. The ESA and training activities were provided through the United States Department of Energy-Save Energy Now initiative, which was established to help the largest natural gas users in the United States identify ways to reduce energy use.

The estimated annual energy cost savings for the projects evaluated is provided in **Table 1** above.

Steam
Steam is provided by two 75,000-pph fire tube boilers operating approximately 82-percent efficiency on average based on combustion testing and steam system modeling. The facility generates steam at 80-psig to meet process requirements. Table 3 provides a summary of data collected during the combustion analysis.

Table 3

Boiler #	Fire Rate (%)	%O2	CO (ppm)	Temperature (F)	Stack Heat Loss (%)
1	54	5.2	3	333	16.8
2	48	4.6	0	328	16.4

The annual cost of steam was estimated at approximately $7 million based on annualized utility data from May 2007 to January 2008. The marginal cost of steam is estimated at $10.47/1,000-lb on average, while the average cost for natural gas was approximately $8.00/MMBtu.

<u>Other Items to Consider</u>
In the course of the assessment a number of non-steam related opportunities were noted and are summarized below for your information:

Variable Speed Drive (VFD) on the Boiler FD Fan
Pressure measurements indicate a pressure drop of approximately 2.8-inwc across the boiler #2 FD fan damper and current measurements (143 amps) provided by staff indicate that the 150-hp motor is 85-percent loaded (128-hp). However, there appears to be a significant discrepancy between the estimated power and combustion air flow estimates based on the 48-percent firing rate obtained from the boiler controller. If the data obtained to date turns out to be correct, there will be a significant opportunity for a VFD. However, this needs further investigation at this time. based on current Based on preliminary estimates there does appear to be an opportunity to apply a VFD but additional testing is necessary to validate this opportunity.

Variable Speed Drive on the Evaporator Recirculation Pumps
Each of the three recirculation pumps is throttled to a valve position of either 35 or 50-percent. As discussed, use of a VFD can reduce electrical power and provide flexibility in control. Since the motors are relatively large at 100-hp or more, this should be considered in the context of overall evaporator improvements not only for power reduction but also for better control.

Lighting
The facility uses high intensity discharge lighting that is a candidate for replacement with 6-lamp T8 fixtures with a high ballast factor ballast. The replacement can usually be made on a one-to-one basis and will reduce lighting cost by approximately 50-percent. For example, the T8 replacement for 400-watt metal halide fixtures will reduce power by approximately 228-watts, while maintain light output on a mean life basis. At $0.06/kWh, replacement of 25-fixtures will reduce electricity cost by approximately $2,900 per year, with a simple Return On Investment (ROI) on the order of 2.4 years. This is recommended for further consideration.

Objective of ESA:
The primary objective of the ESA was to identify steam cost reduction opportunities and to have the primary ESA lead become comfortable with the use of the DOE steam tools.

Focus of Assessment:
SSAT was applied to model cost reduction opportunities identified during walk-throughs and group discussions, with particular attention given to heat recovery boiler efficiency improvement.

Approach for ESA:
The ESA started with an introduction and a brief Power Point presentation introducing the different steam tools. The Steam System Scoping Tool (SSST) was completed during the assessment.

General Observations of Potential Opportunities:
Below are brief descriptions of each opportunity evaluated. Each opportunity has been rated based on the following definitions:

1. <u>Near term opportunities</u>: Include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
2. <u>Medium term opportunities</u>: Require purchase of additional equipment and/or changes in the system such as addition of recuperative air pre-heaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
3. <u>Long term opportunities</u>: Require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

<u>1. Steam Demand Reduction - Recover Heat from the RTO Exhaust for Beer Column Feed Preheating (medium term)</u>
The exhaust from the RTO is hot and contains a significant amount of water vapor, making it suitable for heat recovery with a condensing economizer. Condensing economizers or condensing heat recovery (CHR) systems are designed to allow exhaust to be cooled to a much lower temperature (90°F to 130°F) than is possible with “standard” heat recovery methods because CHR systems can handle the acidic condensate that is formed as the exhaust drops below dew-point. As a result, more energy is recovered and cost savings increase due to the heat released when the water vapor in the exhaust condenses. There is about 1-lb water vapor formed for each 10,000-Btu of gas burned.

Because CHR systems work best when the entering water is cool, it is important to have a relatively cool single pass flow or in the case of recirculated flow, enough heat must be removed to send cool water back to the CHR unit from the point of use. Due to the higher water content of the RTO exhaust, return water temperatures can be hotter than would normally be required for efficient CHR operation.

Technical Feasibility
Based on reviews at other facilities, it may be possible to use the RTO exhaust to preheat beer column feed or some other process stream. Assuming that information from other facilities also applies to United Ethanol, the beer column feed temperature can be increased from 156°F to approximately 189°F.

Estimated Energy Cost Savings
The estimated annual energy cost savings for preheating the beer column feed is $658,000, including deductions for pumping energy. The total installed cost will likely range from $1-million to $2-million once stainless piping, necessary equipment and installation costs are considered. The simple return will range from approximately 1.5 to 3 years.

This project appears favorable and is recommended for further consideration.

Note:
1. Other heat recovery opportunities may apply on the evaporator.

<u>2. Steam Demand Reduction - Use Scrubber Water as Process Condensate Instead of City Water</u>
Based on discussions with facility staff, the scrubber discharge water is sent to drain at approximately 90°F while city water at an average of 55°F is used as process condensate makeup. Design flow from the scrubber is indicated at approximately 43,800-pph.

The annual cost savings from using scrubber discharge as makeup instead of city water is:
43,800-pph x (90-55)°F x 8,400-hr/yr x $8.00/MMBtu ÷ 82% x (1-MMBtu/1,000,000-Btu) = $161,525
Given the primary changes will be related to piping and perhaps controls, the simple return is expected to be less than one year. This opportunity is recommended for further consideration and implementation as appropriate.

<u>3. Improve Boiler Efficiency – Consider Oxygen Trim Control and a Burner Upgrade (medium term)</u>
Oxygen trim control is an automatic means to control boiler efficiency and is controlled by continuous monitoring of the oxygen concentration in the boiler exhaust. Feedback is then provided to a computer that adjusts the combustion air-to-fuel ratio with servo drives. This technology is most suited to boilers that experience a wide variation of load. Based on a evaluation of boiler efficiency, it may be possible to increase efficiency by approximately 1-percent with better control of excess air with oxygen trim control. However, a new burner may also be required to obtain the full efficiency gain.

A more detailed analysis is required to determine the actual benefit possible but it appears reasonable to assume that a gain of ¼ to ½-percent is reasonable, providing an annual cost savings will in the range of $30,000. Based on quotes provided by the facility the simple return will be on the order of 1.5 years.

This opportunity appears to be worthwhile and is recommended for further consideration.

Note:
1. The boiler includes flue gas recirculation (FGR) and the performance of this system needs to be considered in conjunction with any changes made to the burner and controls.

<u>4. Improve Boiler Efficiency – Reduce DA Tank Pressure</u>
The DA tank presently operates at a pressure sufficient to supply water at approximately 225°F to the economizer installed on each boiler. Measurements indicate that the economizers are improving efficiency by approximately 1.4-percent, somewhat less than the 2 to 2.5-percent normally anticipated.

Some improvement can be realized by reducing the DA tank pressure to near the recommended minimum temperature of 215°F. The cooler water to the economizer will recover more heat from the exhaust and improve overall efficiency on the order of 0.25 to 0.5-percent. A 0.25-percent efficiency gain will save an estimated $21,000 per year. The simple return will be immediate since all that is required is a control setpoint change.

This opportunity is recommended for further consideration and implementation as appropriate.

Notes:
1. Checks with a contact thermocouple indicate that the temperature gauges installed in the boiler house are by in large inaccurate and should be replaced.
2. Do not allow the DA tank water temperature to drop below 215°F. Additionally, monitor water chemical use to ensure the DA is removing oxygen as intended.

5. Electricity Cost Reduction – Consider Replacement of Liquid Eductors with Liquid Ring Vacuum Pumps
As an example, the liquid eductor on the evaporator condenser is inefficient compared to a liquid ring vacuum pump (LRVP), with savings of up to 50-percent possible. Based on the differential pump pressure and the curve, this equates to potential of approximately 62-hp for an annual cost savings of $19,425. A more detailed review is necessary to correctly size the LRVP and to determine the power reduction possible. Based with experience on similar systems the simple return could be in the range of 2 to 3 years.

While a LRVP will provide the greatest cost savings, some cost reduction is possible by using the existing VFD to reduce motive water flow to the minimum possible. Pump speed was reduced during the assessment so that the pump pressure was reduced from approximately from 134-psg to 125-psig. Using the similitude laws, this reduction saved approximately 12-hp, equivalent to $4,700 per year over 8,760 hours.

6. Increase Boiler Efficiency: Recover Sensible Heat from Boiler Blowdown (medium term)
The current boiler configuration does not include blow heat recovery, which can be used to preheat boiler makeup water or potentially be discharged directly into process condensate. Greater savings *may* be obtained from use of a shell and tube exchanger to preheat boiler makeup water because the blowdown would experience greater heat removal. Savings will likely range from $6,000 to $9,000 depending on the method, with the simple return ranging from 1 to 3 years depending on the requirements.

This project is recommended for further consideration and implementation as appropriate.

7. Steam Demand Reduction - Minimize Molesieve Super-heater Outlet Temperature
The steam heater that "superheats" the ethanol to the mole sieves appears to have a set point higher than is normally necessary, particularly during the warmer months. Based on an ethanol flow of approximately 5,000-gph and an initial setpoint of 270°F, when the setpoint is reduced to 250°F the savings will be $1.59 per hour and when the setpoint is reduced to 240°F (the design minimum) the savings will be $2.55 per hour. These values were derived through consideration of the enthalpy of ethanol vapor at the temperatures of interest as shown below.
@ 270°F: 506-Btu/lb
@ 250°F: 501-Btu/lb
@ 240°F: 498-Btu/lb

The cost savings at a setpoint of 250°F is:
(506 – 501)-Btu/lb x 5,000-gal/hr x (1-cf/7.48-gal) x 48.9-lb/cf x $8.00/MMBtu ÷ 82% x (1-MMBtu/1,000,000-Btu)
= $1.59/hr

The annual savings will depend on the number of operating hours at each setpoint. To allow an estimate of potential, it is assumed that a setpoint of 250°F is possible for 50-percent of the time, providing an annual cost savings of $6,678.

Note:

1. Because operators can change the setpoint as needed, it will likely be necessary to prepare procedures and train on the importance of maintaining as low a setpoint as possible in consideration of the ambient temperature.

8. Reduce Steam and Condensate Leaks (near term)
Generally, steam and condensate leaks are minimal but a few opportunities were noted. One example is the union near the steam trap on sieve superheater in the boiler house. Repair of leaks should always be a priority when they are found since they are costly. A leak of only 50-pph will cost approximately $5,000 per year. This leak rate is equivalent to a boiler makeup water rate of only 1/10-gpm.

Leak repair will usually pay for itself in less than one year and is recommended as necessary.

Management Support and Comments:
Generally, the initial feedback on the ESA was favorable. Overall, facility staff were engaged, helpful and interested in applying the models to help screen cost reduction opportunities.

DOE Contact at Plant/Company: (who DOE would contact for follow-up regarding progress in implementing ESA results…)

Plant Contact: Norm Scheels

Company Contact: Norm Scheels